

AMENDMENTS TO THE CLAIMS

Claim 1 (Currently Amended): An apparatus comprising:

a design device for designing a controller in accordance with H infinity (H_∞) control logic, the design device employing generalized plants having control object models for manipulated variables, the device including:

storage means for storing said generalized plants;

parameter calculating means having:

setting means for setting a transient response characteristic of a closed loop system consisting of a control object model and said controller; and

frequency sensitivity weight calculation means for calculating the frequency sensitivity weight for determining a set value followup characteristic of said closed loop system in accordance with the transient response characteristic of said closed loop system; and

controller calculation means for deriving said controller by applying said frequency sensitivity weight to said generalized plants stored in said storage means, said setting means approximates the transient response characteristic of said closed loop system with a first-order lag characteristic.

Claim 2 (Previously Presented): The design device of controller according to claim 1, wherein said generalized plants have said control object model, and manipulated variable weight adjusting means for adjusting the input of manipulated variable into said control object model, which is provided in the former stage of said control object model, said parameter calculating means comprises frequency response calculation means for calculating the frequency response calculation means for calculating the frequency responses of said control object models, and scaling matrix calculation means for calculating a scaling matrix T for determining the weighting of said manipulated variables with said manipulated variable weight adjusting means in accordance with the frequency responses of said control object models so that the respective gains of said control object models are consistent, and said controller calculation means calculates the controller by applying said scaling matrix T to the manipulated variable weight adjusting means of said generalized plants stored in said storage means.

Claim 3 (Previously Presented): The design device of controller according to claim 2, wherein said scaling matrix calculation means calculates said scaling matrix T as follows:

$$T = \begin{bmatrix} T_1 & 0 & 0 & \cdots & 0 \\ 0 & T_2 & 0 & \cdots & 0 \\ 0 & 0 & T_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & T_N \end{bmatrix}$$

$$\begin{aligned} T_N = & \frac{1}{L} \cdot \frac{\max(\|G_{y1u1}\|_\infty, \|G_{y1u2}\|_\infty, \dots, \|G_{y1uN}\|_\infty)}{\|G_{y1uN}\|_\infty} \\ & + \frac{1}{L} \cdot \frac{\max(\|G_{y2u1}\|_\infty, \|G_{y2u2}\|_\infty, \dots, \|G_{y2uN}\|_\infty)}{\|G_{y2uN}\|_\infty} \\ & + \dots + \frac{1}{L} \cdot \frac{\max(\|G_{yLu1}\|_\infty, \|G_{yLu2}\|_\infty, \dots, \|G_{yLuN}\|_\infty)}{\|G_{yLuN}\|_\infty} \end{aligned}$$

where the number of manipulated variables u is N (N is a positive integer), the number of controlled variables y is L (L is a positive integer), and the H_∞ norm of the transfer function of said control object model from the N-th manipulated variable u_N to the L-th controlled variable y_L is $\|G_{yLuN}\|_\infty$.

Claim 4 (Previously Presented): The design device of controller according to claim 1, wherein said generalized plants have a first control object model for the manipulated variables, a second control object model for the disturbance, and manipulated variable weight adjusting means for adjusting the input of manipulated variable into the first control object model, which is provided in the former stage of said first control object model, said parameter calculating means comprises frequency response calculation means for calculating the frequency responses of said first control

object model and said second control object model, and scaling matrix calculation means for calculation a scaling matrix T for determining the weighting of the manipulated variables with said manipulated variable weight adjusting means in accordance with the frequency responses of said first and second control object models so that the respective gains of said first control object model are consistent with the maximum values of the gains of said second control object model, and said controller calculation means calculates the parameters of said controller by applying said scaling matrix T to the manipulated variable weight adjusting means of said generalized plants stored in said storage means.

Claim 5 (Canceled)

Claim 6 (Previously Presented): The design device of controller according to claim 2, wherein the generalized plants stored in said storage means have control variable weight adjusting means for adjusting the controlled variable weight adjusting means for adjusting the controlled variables inside a closed loop system consisting of said manipulated variable weight adjusting means, the control object model and the controller, and said design device has setting means for setting a weight matrix S for determining the weighting of the controlled variables with said control variable weight adjusting means.

Claim 7 (Previously Presented): The design device of controller according to claim 4, wherein the generalized plants stored in said storage means have control variable weight adjusting means for adjusting the controlled variables inside a closed loop system consisting of said manipulated variable weight adjusting means, the first control object model and the controller, and said design device has setting means for setting a weight matrix S for determining the weighting of the controlled variables with said control variable weight adjusting means.

Claim 8 (Previously Presented): The design device of controller according to claim 2, wherein the generalized plants stored in said storage means have control variable weight adjusting means for adjusting the controlled variables in the former or latter stage of frequency sensitivity weight adjusting means for determining the set value followup characteristic of a closed loop system consisting of said manipulated

variable weight adjusting means, the control object model and the controller, and said design device has setting means for setting a weight matrix S for determining the weighting of the controlled variables with said control variable weight adjusting means.

Claim 9 (Previously Presented): The design device of controller according to claim 4, wherein the generalized plants stored in said storage means have control variable weight adjusting means for adjusting the controlled variables in the former or latter stage of frequency sensitivity weight adjusting means for determining the set value followup characteristic of a closed loop system consisting of said manipulated variable weight adjusting means, the first control object model and the controller, and said design device has setting means for setting a weight matrix S for determining the weighting of the controlled variables with said control variable weight adjusting means.

Claim 10 (Canceled)

Claim 11 (Previously Presented): The design device of controller according to claim 1, wherein said frequency sensitivity weight calculation unit calculates said frequency sensitivity weight in accordance with the transient response characteristic of said closed loop system, and a design index that the H_∞ norm of the transfer function of the closed loop system from the set value to the deviation multiplied by said frequency sensitivity weight is less than 1.

Claims 12-13 (Canceled)

Claim 14 (New): An apparatus comprising:

a design device for designing a controller in accordance with H infinity (H_∞) control logic, the design device employing generalized plants having control object models for manipulated variables, the device including:

storage means for storing said generalized plants;

parameter calculating means having:

setting means for setting a transient response characteristic of a closed loop system consisting of a control object model and said controller; and

frequency sensitivity weight calculation means for calculating the frequency sensitivity weight for determining a set value followup characteristic of said closed loop

system in accordance with the transient response characteristic of said closed loop system; and

controller calculation means for deriving said controller by applying said frequency sensitivity weight to said generalized plants stored in said storage means, wherein said setting means approximates the transient response characteristic of said closed loop system with a second-order system characteristic.

Claim 15 (New): The design device of controller according to claim 4, wherein said scaling matrix calculation means calculates said scaling matrix T as follows:

$$T = \begin{bmatrix} T_1 & 0 & 0 & \cdots & 0 \\ 0 & T_2 & 0 & \cdots & 0 \\ 0 & 0 & T_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & T_N \end{bmatrix}$$

$$T_N = \frac{1}{L} \cdot \frac{\max \left(\|G_{y1w1}\|_{\infty}, \|G_{y1w2}\|_{\infty}, \cdots, \|G_{y1wJ}\|_{\infty} \right)}{\|G_{y1uN}\|_{\infty}}$$

$$+ \frac{1}{L} \cdot \frac{\max \left(\|G_{y2w1}\|_{\infty}, \|G_{y2w2}\|_{\infty}, \cdots, \|G_{y2wJ}\|_{\infty} \right)}{\|G_{y2uN}\|_{\infty}}$$

$$+ \cdots + \frac{1}{L} \cdot \frac{\max \left(\|G_{yLw1}\|_{\infty}, \|G_{yLw2}\|_{\infty}, \cdots, \|G_{yLwJ}\|_{\infty} \right)}{\|G_{yLuN}\|_{\infty}}$$

where the number of manipulated variables u is N (N is a positive integer), the number of disturbance w is J (J is a positive integer), the number of controlled variable y is L (L is a positive integer), the H_{∞} norm of the transfer function of said first control object model from the N-th manipulated variable u_N to the L-th controlled variable y_L is $\|G_{yLuN}\|_{\infty}$.